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Draw a cross through the box (☒) if you have NOT written in this booklet

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SCHOLARSHIP EXEMPLAR

NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Scholarship 2023
Biology

Time allowed: Three hours
Total score: 24

ANSWER BOOKLET

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

Write your answers in this booklet.

Start your answer to each question on a new page. Carefully number each question.

Check that this booklet has pages 2–27 in the correct order. Pages 2–4 are blank and are to be used for planning. Pages 5–27 are lined pages for writing your answers.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

PLANNING

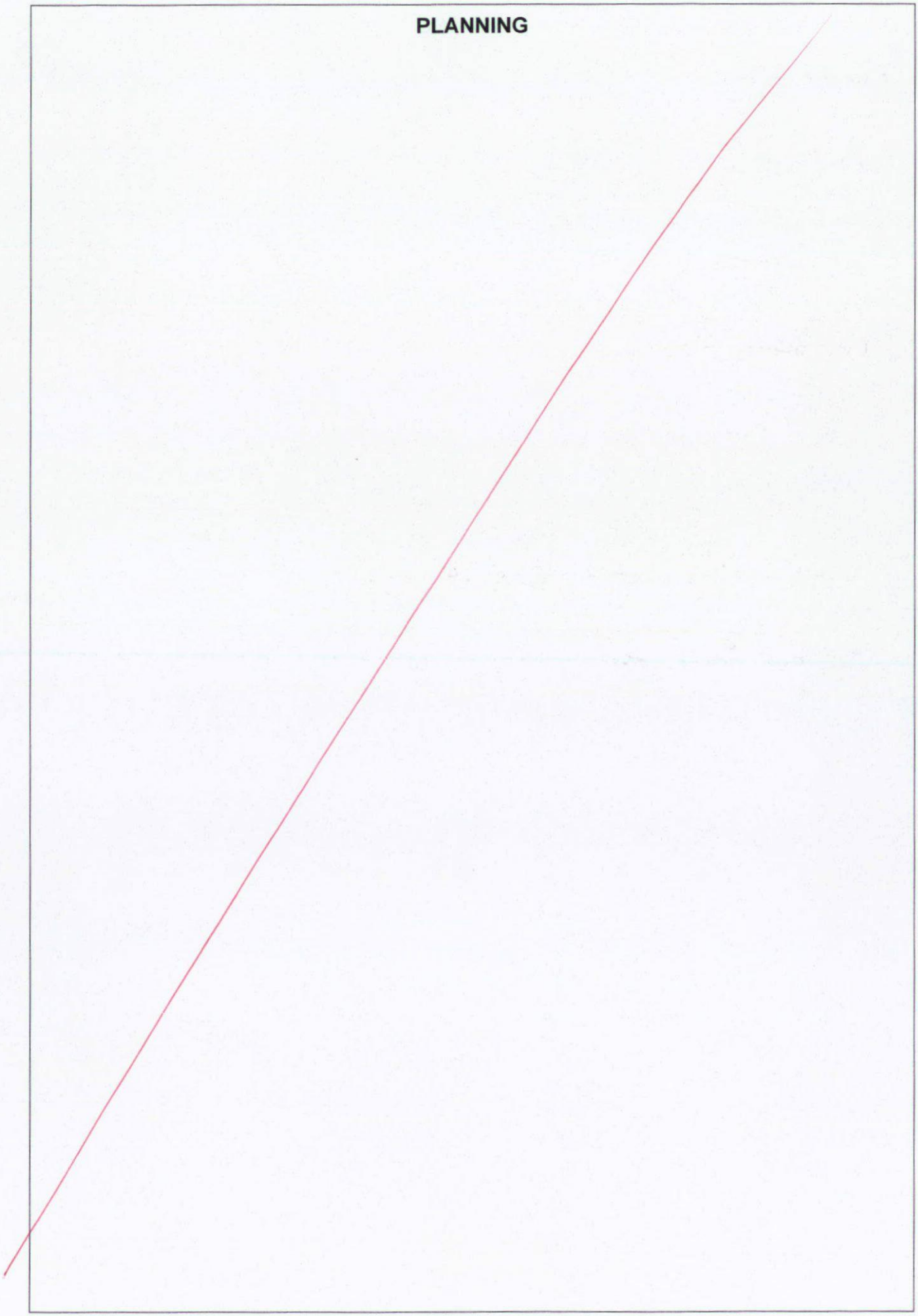
PENCIL

Decline

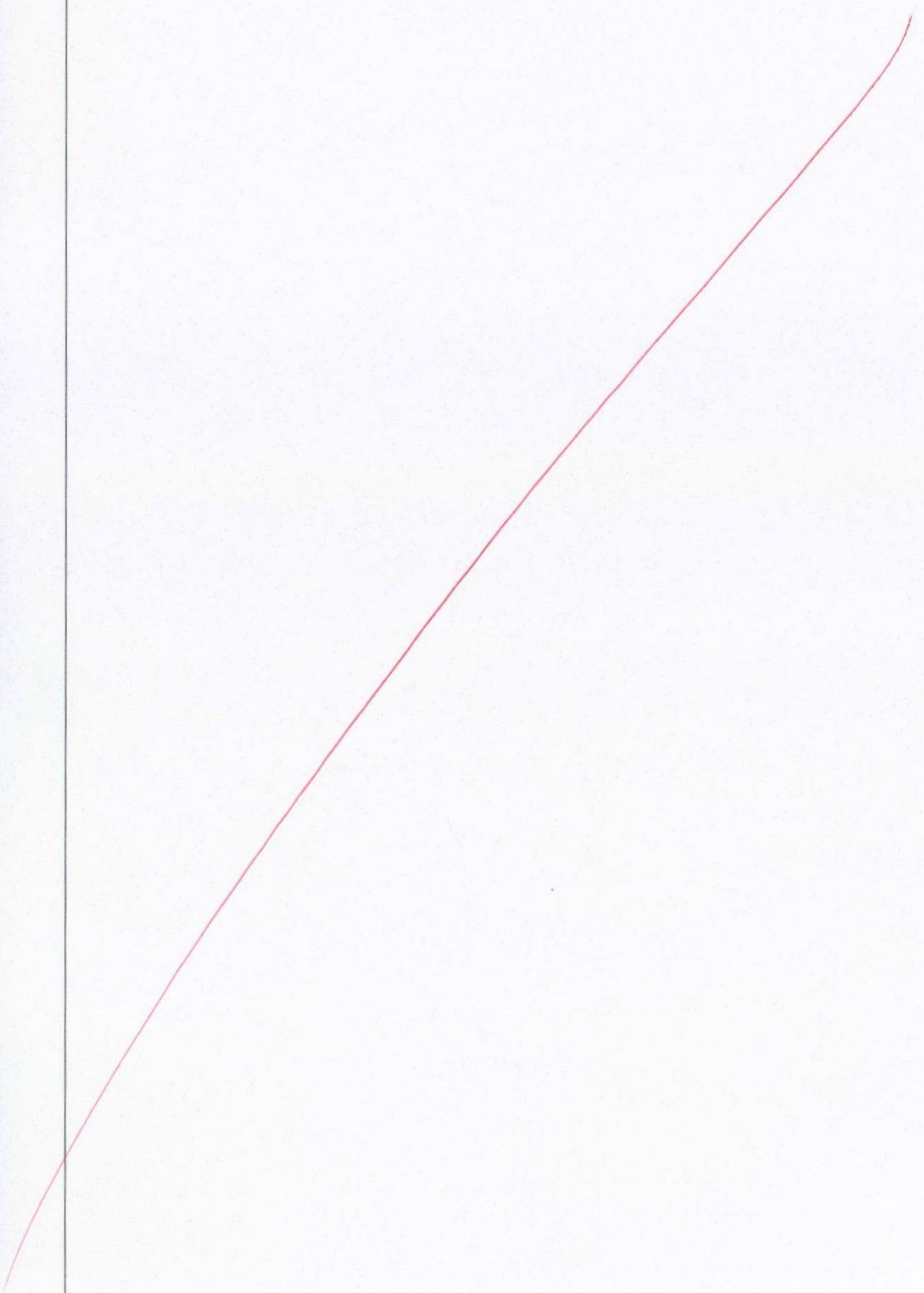
1. Territory –
2. Resources ✓
3. K-selected –
   - ↳ Territory –
4. Hunting
5. Habitat Destruction / loss of food
6. Resistance to antibotic

Interventions

PLANNING



PLANNING



Question 1 : The Iberian Lynx //

The Iberian lynx has, over time, gone from being widespread across Spain and Portugal in the 19th Century to becoming endangered in the ~~20~~ 21st century, particularly in recent years. There are a number of different factors, both in the ecological environment and the biological features of this species that have contributed to this decline in numbers. //

The Iberian Lynx displays territorialism as adults live in solidarity in geographical areas of up to 20 km². These areas are marked by scent and defended from others of its species likely by agonistic behaviours. Male and female territories overlap to allow for breeding. This territorial activity, while beneficial in providing resources and safety to the individual, has contributed to the endangerment of the Lynx as the ~~high~~ large area required for each individual means that this species has been incredibly susceptible to the effects of habitat loss. The fragmentations of suitable habitats ~~has~~ through habitat destruction has resulted in a significant loss in available area for this species, increasing intraspecific competition between individuals. In the early 21st century this species has became isolated to 2 populations, likely reflecting the significant loss in habitat due to humans. This habitat loss has meant that many individuals have been unable to find a suitable

territory and hence, have been unable to ~~to~~ mate to produce offspring. Overtime, this results in less offspring being produced by the population, decreasing the numbers, resulting in endangerment. //

The Iberian Lynx has a diet that mainly consists of European Rabbits although it is able to feed on other animals if required. For a mother rearing young, it can require about 3 rabbits each day for mother and young to survive. This has contributed to the decline of the species as this resource has significantly declined overtime due to epidemics within rabbit populations (myxomatosis and haemorrhagic) The predation of the Iberian lynx on the rabbit is dependent on the availability of prey, and overtime, as prey has declined, it has affected the population of predator due to their close relationship. //

~~A2 k-sele~~ The Iberian Lynx is a K-selected species as parental care is displayed by females in this species and each individual produces only 3 kits per litter. Parental care usually lasts around 20 months. Parental care presents a risk for the female mothers as it requires time and energy to care for and find resources for young. This decreases the chance of survival for mothers as it can be likely that they are unable to defend both themselves and their young

from the environment. This can result in a loss of breeding females from the population if many are dying as a result of protecting their young. If this occurs in the early stages of development, young may also not survive. Within this species, the survival and reproductive rates of offspring is also generally quite poor. Generally, only 2 of 3 offspring will survive past weaning, meaning females will waste energy in carrying and caring for an offspring which does not survive. ~~Offspring~~ In addition, it can take up to 5 years for a female to find a territory, meaning females do not breed during this time. This puts females at risk of not reproducing as in this time, they may be killed. It also results in each female only producing a small number of offspring as it reduces the number of litters each female will produce in ~~#~~ her lifetime. These parental behaviours and breeding behaviours displayed particularly by female Lynx have contributed to the ~~f~~ decline in its population as reproductive success is quite low and survival rates of both mothers and young is low. Over time, this has caused a decrease in numbers.

The impact of human behaviour has also had an ~~impac~~ affect on the endangerment of Iberian lynx over the years. ~~Pred~~ Exploitation through predation on this lynx species in Europe has caused a major

decline in the size of the population. Hunting behaviours have meant that this species in the past has been killed for sport, resulting in a loss in mass numbers.

The introduction of an anti-biotic resistant bacteria in the Iberian Lynx population has also had an effect on numbers. This resistance has likely come about through a mutation of its alleles. This resistance means that infections within the population are difficult to treat, and hence, when arisen, can kill a large number of individuals, causing a mass decline.

In order to avoid the extinction of the species, many interventions have been undertaken.

By creating protected areas and wildlife corridors, it protects the lynx from potential disease, as well as human affects. It stops the effect of habitat destruction on this species by creating areas which are reserves and cannot be built on, allowing this species to continue to live in the same territories. With this, previously inhabited areas have also been reintroduced, in order to expand the available habitat of this species. This allows more individuals to find territories as it was discussed that each individual requires a large geographical area

to thrive. By protecting areas, it also ensures efforts are undertaken to reduce the introduction of disease from other species, which may be detrimental to the small population of the Iberian lynx. //

Restocking rabbits in these habitats would help avoid extinction as a major cause of decline was the significant decrease in diet due to rabbit epidemics. By restocking rabbits, a r-selected species, they would quickly reproduce to create a large rabbit population within lynx habitats, to increase food availability for the Iberian lynx. This would allow more individuals to survive and reproduce. //

A captive breeding program would also help avoid extinction as it could ensure a higher offspring survival rate, quickly introducing more individuals to the population. By storing lynx embryos and ~~sel~~ oocytes, if ~~a~~ ~~Rare~~ genetic drift were to occur and the population saw another drop in numbers, individuals could be reintroduced, avoiding extinction. //

The long term viability of the species could be managed through genetic modification. One cause of population decline ~~does~~ is identified to be inbreeding resulting in genetic defects and low genetic diversity. Through genetic modification, beneficial ~~ge~~ alleles could be introduced into the

population, hence increasing genetic diversity into the population. Genetic defects could also be replaced for more ideal characteristics which could be obtained from other similar feline species. Techniques such as transgenisis, where genetic code is inserted from one species into another could be very effective in the long term survival of the Iberian Lynx Species in achieving a favourable conservation status.

Question 2. : The Lancewood and the MOA

The relationship between the Moa and the NZ lancewood is one of herbivory where the moa (herbivore) consumes all of a part of the lancewood (plant). Because of this close relationship, co-evolution has occured between these two species as the affect of one species has resulted in the evolution of the other. The characteristic of heteroblasty in the Lancewood is likely a result of selection pressures by the moa.

In the first stage of the lancewood life cycle, the plant appears as brown and mottled, a form of defensive colouration. This makes the plant appear non-palatable and of low nutritional value, making it unappealing to the moa. The plant, in its seedling stage presents as similar to other non-palatible plant matter on the forest floor such as dried leaves and sticks. This is a form of mimicry as the plant presents itself in such a way to appear like other species that the mammal, the moa would recognise to not be food. A research shows that moa would have had difficulty distinguishing the lancewood seedlings against the background of leaf little, meaning this defensive colouring allowed this species to camoflague into the environment. This presented a benefit for the species, as at

this stage, the ~~organism~~ plant would be highly susceptible to being lost completely, as a moa, being such a large mammal, would likely feed on the whole ~~organism~~ plant. Hence, it would decrease survival of the species as individuals are unable to mature and reproduce.

In the next stage, the plant, a juvenile, aquires brightly coloured spots on its leaf. This appearance is vastly different to the previous stage. This is likely because as the plant grows, it becomes increasingly difficult to camoflague against the leaf litter, and hence, the brown appearance no longer protects the young lacewood plant against the moa. Instead, the bright coloured spots serve as a warning for moa, and for the moa, this appearance is associated with danger. This is likely another example of mimicry from the lacewood, where it appears as another species the moa ~~does~~ understands to be non-palatible. This appearance continues to ward off the moa, preventing it from feeding on the ~~plant~~ young plant. This is because it would be a risk to the survival of individual plants and hence to the species survival as a whole.

The nutritional value of young lacewood also has evolved as a result of selection pressures

from the moa. The selection pressure from moa feeding on this species would have caused those with low nutritional value to be selected for over time, as these were less attractive for potential ~~f~~ feeders. Young leaves contain 5 times less protein and slightly less soluble carbohydrate as mature leaves, preventing young seedlings from being fed on, as over time, moa would learn and evolve to feed on mature leaves rather than young saplings, an example of co-evolution. //

In the next stage of development, the lancewood appears as metre-long barbed spears slanted downwards. This presents an attraction for moa and appears as a palatable food source for the moa. It allows large mammals such as the moa to feed on it as it has adapted to the shape of their necks and throats to allow moa to easily consume these leaves. The evolution of the lancewood to adapt to feeding from moa ~~coated seed~~ indicates a benefit of moa to the lancewood which selected for this appearance. It indicates a relationship of mutualism between the 2 species. This could be because the moa helps to distribute the seeds of the lancewood, allowing for an increase in reproductive success as seeds are able to be placed in more available areas with less intraspecific competition. Or, the moa may be beneficial to

the lancewood in the form of provicling the necessary nutrients for this stage of growth of this plant and its droppings may act as a fertilisar for the plant. At this stage, the plant is able to be feed on by the moa as its size means the individual plant is able to survive, whereas previously, it was too small. The relationship between moa and lancewood at this stage benefits both species as the moa has an available food sourca. //

In the next stage, the leaves point upwards, and a tall straight trunk of up to 20m forms. At this stage, moa no longer feed on the leaves. This may have evolved in such a way as at maturity, the presence of moa no longer provides a benefit to the species and instead, the resource of sunlight for photosynthesis is required for the plants survival. Because of this, the lancewood grows to be very tall in order to compete with other surrounding species (interspecific competition) for sunlight. //

It is clear through comparing the NZ lancewood and the Chatham Islands Lancewood that the presence of the moa has greatly impacted its Evolution as the Chatham Island Lancewood did not encounter any flightless browsing birds and hence, did

not display heteroblasty in its life cycle. From Figure E, we see that this plant remains "tree like" from the time it is a sapling with bright green leaves (browsing) as the selection pressure of herbivores was not present and hence it did not have to adapt any defense mechanisms. //

Despite the extinction of the moa, the NZ lancewood did not lose its heteroblastic life cycle. This is likely due to the absense of any negative selection pressures that would force the species to select for different characteristics. The heteroblastic life cycle may still be beneficial to the species as NZ continues to ~~be~~ have many flightless mammals which may still feed on saplings. Hence, in appearing non-~~pal~~ palatable as a sapling, the species continues to be defended against birds and other mammals and the trait is selected for. //

The impact of humans may also cause the NZ lancewood to retain its heteroblastic life cycle. Human intervention has ~~caused~~ affected many of NZ's native plant species. In ~~remaining~~ keeping its initial appearance, it may protect the species against the threat of humans as we are less likely to remove it from its natural environment due to its unappealing appearance. It is said that early botanists were unaware the several stages belonged to one species. Hence, humans

could have created a selection pressure to select ~~against~~ for the hetroblastic life cycle, as it prevented the ~~species~~ plant from being killed before reproduction, hence resulting is increased reproductive success. //

Overall, in order for the ~~sp~~ characteristic of heteroblasty to be selected for, it likely does provide a benefit to the species today in the absense of the mod, as it requires energy for the plant to have such an appearance and to drastically alter its appearance. The benefits must outweigh this cost of loss in energy for it to be continued to be selected for. //

Question 3: The pāvera and the milloard. //

The concept of biological species is that two populations are of different species if they are reproductively isolated and are unable to produce a fertile, viable offspring. Often, reproduction between two species is prevented by one or more reproductive isolating mechanisms. In the case of the Pārera and the malland, this idea of biological species does not distinguish the species. ~~as~~ although in the past, geographic isolation has prevented interbreeding between ~~two~~ the two populations which have evolved separately, ~~in~~ (allopatrically), the migration of malland into NZ has removed this RIM of geographic isolation. It has ~~there~~ hence allowed the pāvera and malland to interbreed to produce a hybrid species. This does not ~~fundamental~~ align with the fundamental concept of a biological species and under this concept, the two populations are difficult to be classified as seperate species. //

The RIM of geographical isolation is one which is not present between the two populations as with the movement of Malland into NZ from Australia, the populations are no longer separated by any physical barrier. //

Similarily, ecological habitats of the pāvera and malland are not isolated, as although they have evolved to

different ecological niches, their habitat within NZ appears to be very similar and this has allowed them to interact and reproduce. It is likely without Mallard, Pūtea would have evolved to expand into wetlands. //

Structural Isolation between the two duck species is not present as the structure and features (physical) of the two species is very similar. Pūtea have an average length of 50-60cm and a mass of 900-1200g whereas Mallard have an average length of 50-70cm and an average mass of 1050-1300g. This shows significant overlap between the structure of the 2 species and from Figure 5, they appear to have a similar build. This means the structural anatomy of the two would not inhibit the transfer of gametes. //

Gametic Isolation seems to also not be present for the two species as a viable hybrid is able to be produced, indicating compatibility of gametes. //

The Pūtea and Mallard are not temporally isolated as there is much similarity between breeding months (Aug-Dec VS Jul-Dec), Egg laying months (Aug-Oct VS Jul-Oct) and Incubation period (26-29 days VS 27-28 days). The great similarities and overlaps between the breeding seasonal behaviours of the two groups means that they are not isolated by their mating

times as both would be looking for mates around the some seasonal periods.

~~Both~~ The two also seem to not be ~~Isolated~~ reproductively isolated by behavioural isolation, due to a similar appearance. It is likely that individuals of each species would recognise the other as a potential mate due to a similarity in appearance.

The two species likely are able to interbreed and share many characteristics as they ~~share~~ have evolved from a common ancestor through divergent evolution as they each evolved to different selection pressures in different available niches in their respective locations. Thus adaptive radiation would have taken place.

Evidence that could be used to distinguish the two species would include genetic analysis and other more specific physical or behavioural traits and characteristics.

For example, it is said that the clutch size of Petrova is 8-10 eggs whereas for Mallard it is 10-13. There is little overlap is this meaning for a duck that lays are 10 eggs, you can expect it to most likely be of Mallard species. However, this is not certain and should be confirmed by other evidence.

The Mallard and Pāteva evolved to differing ecological niches ~~which~~ in which allopatric speciation took place. Mallard are adapted to open shallow grassland. Pāteva have adapted to wetlands covered by trees and bush. The evolution to selection pressures in each of the environments would show different traits in each species, as they diverged over time before Mallard were introduced to NZ. For example, pāteva would tend to have a rounder shape as covered wetlands ~~are~~ present a colder climate meaning a rounder body would reduce ~~surface~~ area ~~to~~ to volume ratio, allowing the species to better retain its body heat and thermoregulate. In comparison, the Mallard likely have thinner bodies as open grasslands expose them to heat from the sun meaning they need a larger surface area in order to release excess heat. Physical features such as this may be a good indicator of the species. //

Additionally, a way to determine for certain the species of a duck would be to undergo genetic analysis where a DNA sample of each is taken and Genetic sequencing is analysed to see the ~~mutations~~ alleles and mutations present in each, to trace the origin of the species. It is likely we would see a very similar DNA sequence in each, as hybridisation ~~easily~~ readily occurs meaning ~~the~~ chromosomes are able to easily match up ~~to~~ during meiosis. //

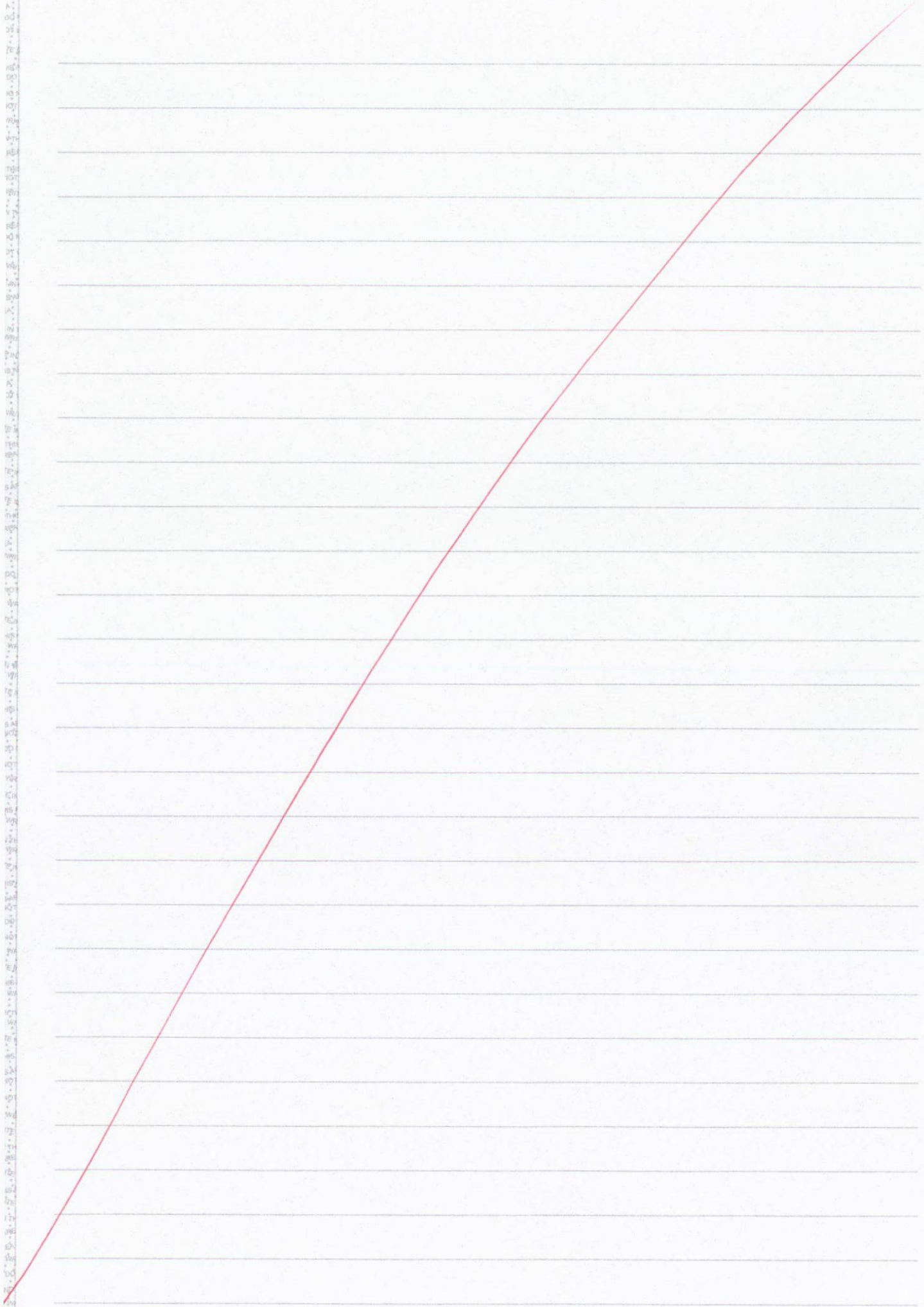
The Pāteva is an endemic species to NZ, meaning it can only be found in NZ. The Malland however, is not endemic to NZ and was brought from Australia. As these two species are able to hybridise and have thus produced a hybrid swarm, the idea of species regarding these two populations presents a unique challenge in managing the groups.

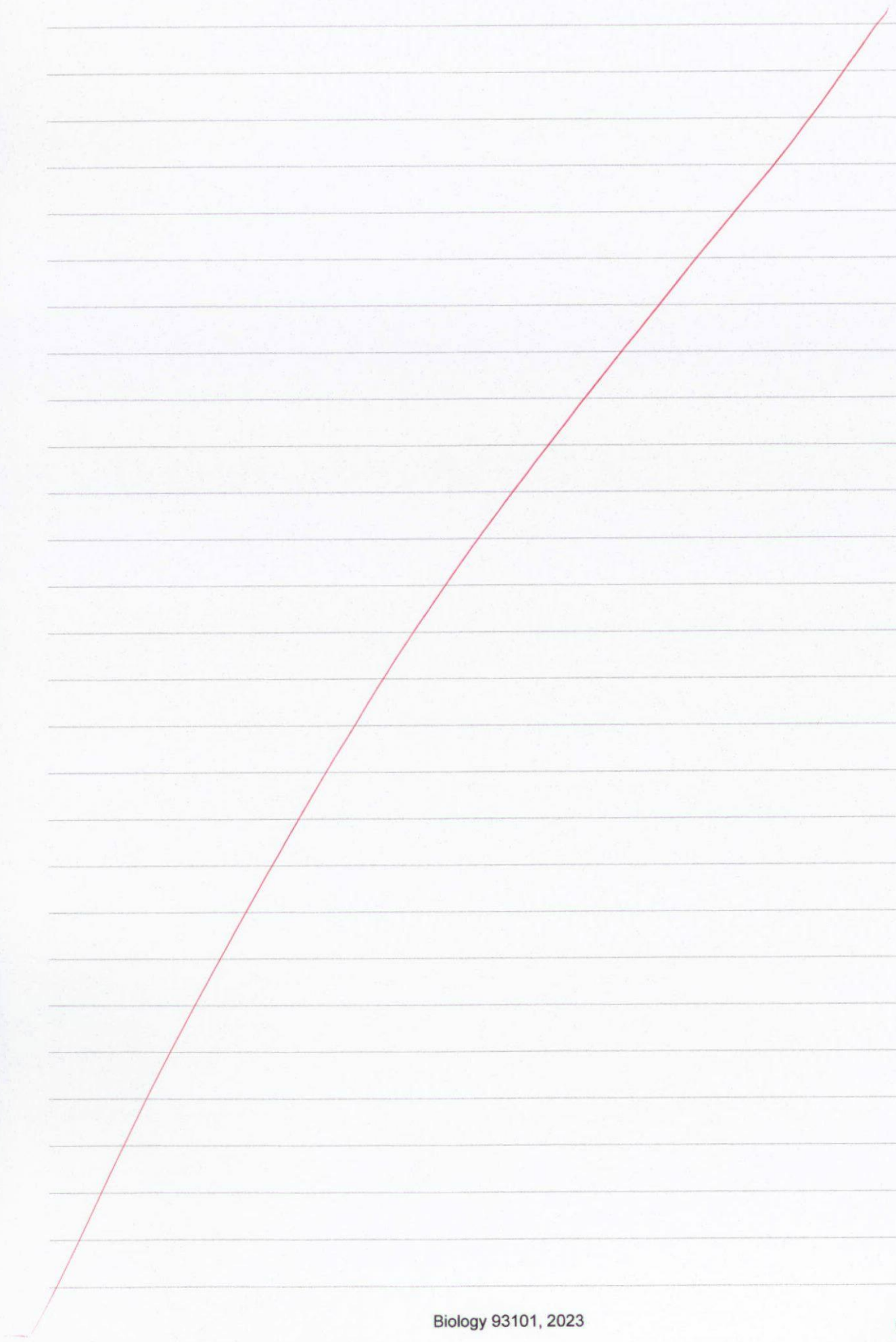
The NZ Pāteva has a "critical" status as majority of the species has hybridised with the Malland and there are few pure Pāteva. Because of this extinction through hybridisation is occuring. However, as these two groups are able to interbreed, it is difficult to definitively say whether they are unique species and the two may be so closely related that they are of the same species. Because of this, the NZ pāteva, while in decline, is not classified to be high risk as it is not unique such that other NZ native birds are. Hence, decisions regarding management of the two species are challenging.

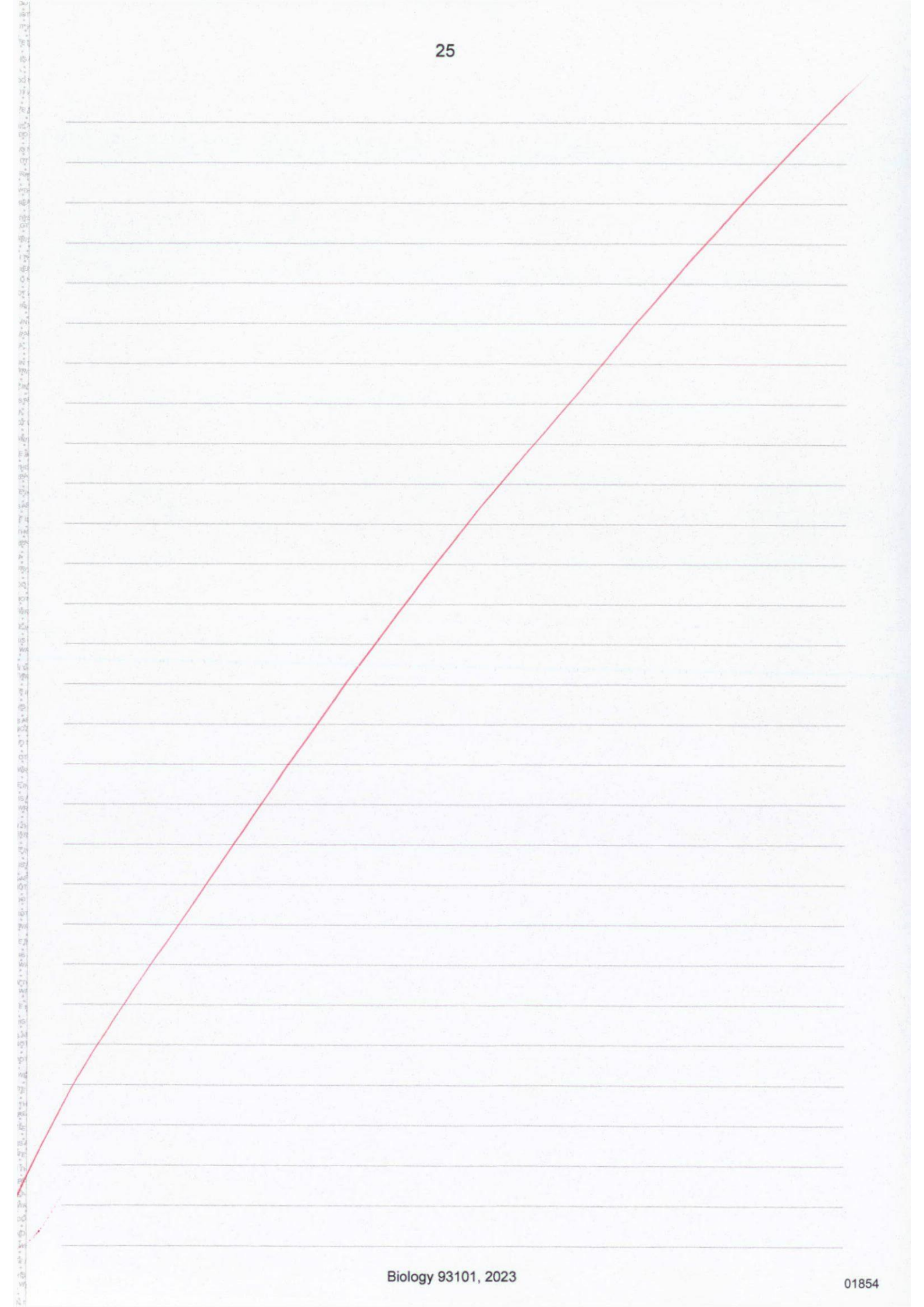
The hunting of Malland and Pāteva is one challenge that is presented. Malland are a common duck, and hence, there is little issue in hunting during game bird hunting season, in terms of biological evolution. However, due to the hybridisation of Malland and Pāteva, and the similar appearances between the two species, hunters cannot differentiate between the two and hence,

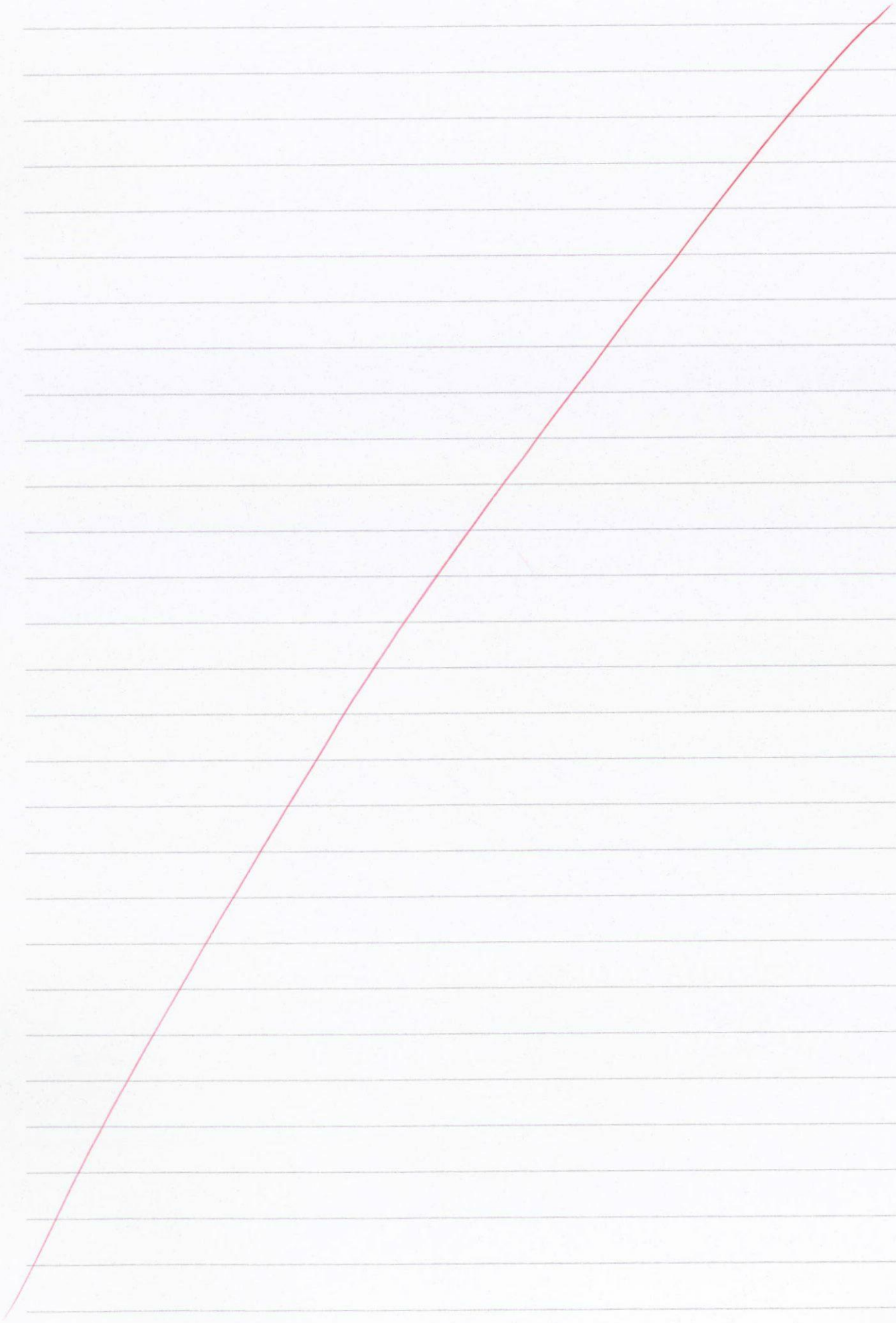
the decision ~~was~~ has been made that both are legal to hunt. This decision contributes to the endangerment of the pāteke species as it is allowing this species to be killed. However, the hybridisation of the Mallard and Pāteke has allowed for this decision.

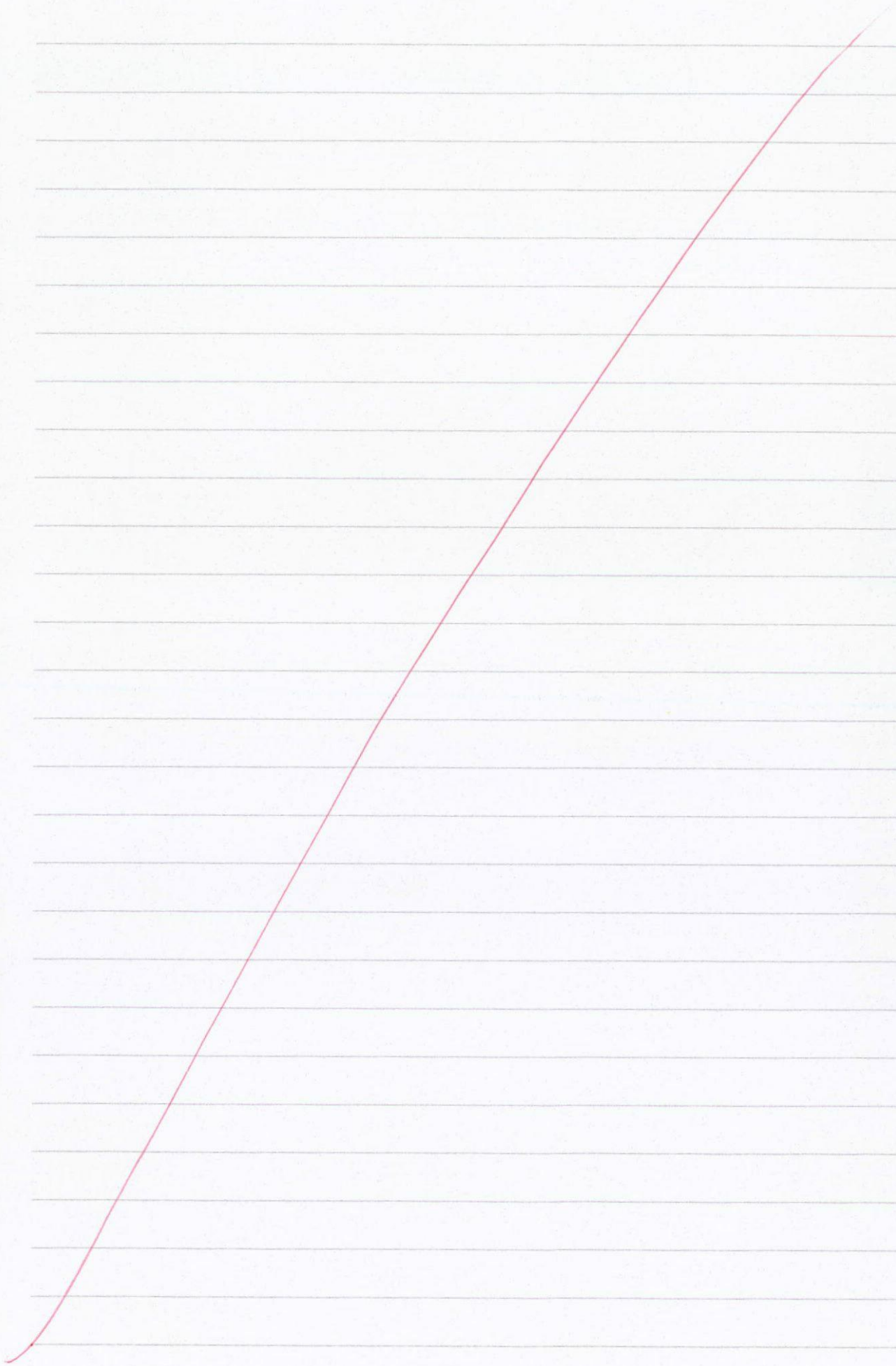
~~Se~~ Preservation efforts have also been impacted by this. As the extinction of Pāteke is not driven by habitat loss, predation, disease or other similar factors, the Mallard population would have to be decreased to stop extinction by hybridisation.











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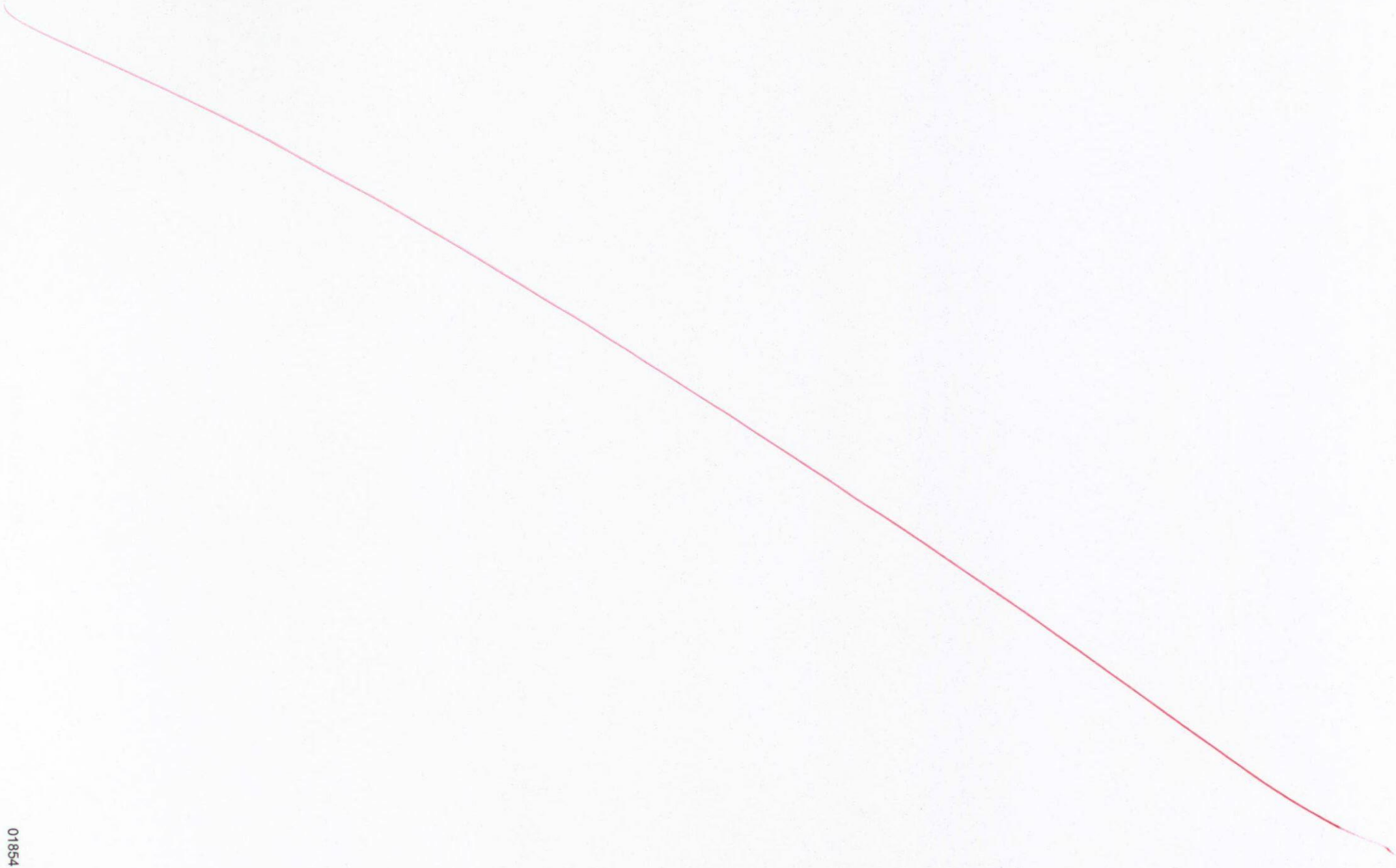

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Scholarship

Subject: Biology

Standard: 93101

Total score: 16

Q	Score	Marker commentary
1	04	The candidate has discussed the effect of habit destruction by humans on lynx territories. They linked the slow rate of reproduction and K-reproductive strategy of the lynx to its population decline due to slow replacement and lack of food, resources, and territories. They analysed the impact of the presence of antibiotic-resistant bacteria in lynx, linking it to ongoing issues related to hard-to-treat infections. The candidate explained the interventions currently in place to ensure the lynx population is recovering such as creating protected areas, restocking rabbits, and translocating lynx from one isolated population to another; however, they did not justify the benefits in enough detail to gain evidence points in this section. Suggestions of future management strategies were not relevant or detailed enough for justification points in the third part of the question. This candidate gained 3 justification points and 2 evidence points.
2	06	Critical thinking and clear communication was evident in the candidate's justification of the heteroblastic features of the lancewood / horoeka in response to moa browsing. Evaluation of the adaptive significance of cryptic colouration and low nutrient levels at different stages of the life cycle was made. Justification of the presence of these features as a result of moa browsing was linked to the absence of heteroblasty in Chatham Island lancewood due to the absence of moa as a selection pressure. The persistence of these features despite moa extinction was analysed with an insightful statement, including lack of significant selection pressures with the current phenotype not reducing fitness. There some errors in this response, such as lancewood / horoeka producing barbed leaves to encourage moa herbivory but, overall, the candidate demonstrated a good understanding of justification points across both areas of the question. This candidate gained 5 justification points and 2 evidence points.

Q	Score	Marker commentary
3	06	The candidate has analysed the challenges with geographically separated species when classifying them as a separate species, due to the potential for successful interbreeding, if geographical barriers are removed. They fully discussed how hybridization of the two duck species to produce fertile offspring that show hybrid vigour / increased fitness highlights the limitation of the species concept. The difficulties in identifying the pārera and mallard were analysed with genetic analysis clearly identified as an accurate method, while acknowledging the challenges that hybrid genome analysis provide due to genetic mixing. The candidate did not provide examples of species other than the mallard and pārera to illustrate the limitations of the species concept. This candidate gained 4 justification points across all three areas of the question and 4 evidence points.